Executive Summary: Treated Wood

Ted Poston, Battelle

As part of the process outlined in Washington's *Statewide Strategy to Recover Salmon: Extinction is Not an Option* the Washington Departments of Fish and Wildlife, Ecology, and Transportation were charged to develop Aquatic Habitat Guidelines employing an integrated approach to marine, freshwater, and riparian habitat protection and restoration. Guidelines will be issued, as funding allows, in a series of manuals addressing many aspects of aquatic and riparian habitat protection and restoration.

This document is one of a series of white papers developed to provide a legitimate scientific and technical basis for developing Aquatic Habitat Guidelines. The white papers address the current understanding of impacts of development and land management activities on aquatic habitat, and potential mitigation for these impacts. Individual white papers will not necessarily result in a corresponding guidance document. Instead, guidance document development, addressing management and technical assistance needs, may incorporate information synthesized from one or more of the white papers.

The scope of work for each white paper requested a “comprehensive but not exhaustive” review of the peer-reviewed scientific literature, symposia literature, and technical (gray) literature, with an emphasis on the peer-reviewed literature. The reader of this report can therefore expect a broad review of the literature, which is current through late 2000. Several of the white papers also contain similar elements including the following sections: overview of the guidelines project, overview of the subject white paper, assessment of the state of knowledge, summary of existing guidance, recommendations for future guidance documents, glossary of technical terms, and bibliography.

Focus of the Assessment

This white paper provides an assessment of current research on chemical contaminants in treated wood and the potential for adverse impact to salmon listed under the Endangered Species Act as well as other aquatic resources. The assessment focuses on recent (within the past 10 years) field-oriented studies that evaluate the spatial and temporal distribution of toxic constituents used in treated wood. However, most of the field studies specifically addressing treated wood installations did not address salmonids as a targeted receptor.

Types of Wood Structures Studied

Evaluations of treated wood structures were generally restricted to smaller installations such as bridges, docks, dolphins, or bulkheads. No studies of large installations were found. Larger installations of treated wood (e.g., greater than 50 pilings) are generally associated with waterfront property in industrial areas and municipalities. The assessment of potential impacts associated with the use of treated wood in larger installations is likely confounded with other sources of anthropogenic contamination and environmental stress. For both large and small installations, any attempt to assess potential impacts of the use of treated wood should include an assessment of cumulative impacts. Hypothetical examples are provided of The Council of Environmental Quality's four types of cumulative effects, which are based on the number of actions and how they interact.

Major Types of Wood Treatment

The potential impacts resulting from preservatives found in three major types of treated wood are addressed: creosote, ACZA (ammoniacal copper zinc arsenate), and CCA Type C (chromated copper arsenate). Creosote used as a wood preservative is a distillate of coal tar produced by high temperature carbonization of bituminous coal. The contaminant of interest in creosote-treated wood is a complex mixture of polycyclic aromatic hydrocarbons (PAH). Polycyclic aromatic hydrocarbons have metabolic intermediates that are carcinogenic and, under chronic exposure, may induce developmental toxicity. Contaminants associated with ACZA and CCA treated wood include copper, arsenate, zinc and chromate, of which copper provides the greatest risk to aquatic organisms. Effects were addressed for freshwater, estuarine, and marine environments.

Water Quality and Sediment Standards

Contaminants that migrate from treated wood by either diffusion or leaching can be compared to water or sediment quality standards and benchmarks. It is concluded that water quality standards for metals are generally appropriate for the protection of aquatic organisms; however, existing standards for sediment and for complex mixtures of PAH need to be re-evaluated in terms of potential for impacts to biota and sediment accumulation. Recent research associated with oil spills has provided more toxicological information on low-level chronic exposure to PAH that may be useful for assessing sediment and water quality standards or benchmarks. (The studies of Heintz et al. (1999) and Carls et al. (1999) provide a foundation for establishing an ecological toxic benchmark of 0.4 to 1.0 µg/L total dissolved PAH based on developmental toxicity in cold water fish. Similarly, concentrations of total PAH dissolved in water from creosote treated wood could be expected to exert the same influence on aquatic life as that demonstrated with weathered oil.)

Overall Conclusions

The overall conclusions of this assessment include the following:

- The propensity for trace metals (from wood treated with ACZA or CCA Type C) or PAH (from wood treated with creosote) to result in long-term water column impacts are much lower than their potential for impacts to sediment. Short-term acute toxic impacts are possible, but the decrease in diffusion or leaching rates of contaminants over time reduces the risk of acute impacts in the water column.

- For the size of treated wood structures evaluated in this review, the spatial extent of impact is generally small and limited to areas in the immediate vicinity of the structure. Extra consideration needs to be given to large treated wood projects.

- The relative hazard of creosote treated wood is generally greater than the hazard associated with CCA Type C or ACZA treated wood in terms of temporal and spatial impact. Consideration needs to be given to site-specific conditions.

CCA Type C or ACZA treated wood is generally preferred to the use of creosote treated wood as a more environmentally friendly product.

Creosote Treated Wood

Adverse environmental effects associated with creosote treated wood are manifested in the accumulation of contaminants in sediment and direct impacts to biota that may colonize the treated wood structure. Critical impacts resulting from the installation of creosote treated wood are dependent on the amount of treated wood installed, and the physical condition of the installation site. Creosote treated wood is not allowed in lakes in Washington and has increasingly limited use in rivers in inland Washington. In Puget Sound and along the coast historic use in estuarine and marine environments is rapidly declining due to ESA considerations for listed salmonids.

It is the chronic release of PAH that ultimately impacts the sediment and associated benthic environment. Key physical variables are the turn over of water (currents or tidal action) and the sediment characteristics. The key sediment characteristic for PAH is organic carbon content. These variables will have great impact on the fate of contaminants in the sediments. Under oxidizing conditions, PAHs can be metabolized by microbes and degraded. Implementation of BMP processing has likely reduced the amount of excess creosote on modern treated wood products compared to earlier processes.

The duration of diffusion of PAH from the retention zone of creosote treated wood is a long-term process that may last the life of the product. Pilings over 50 years old still contain sufficient amounts of creosote to kill herring embryos (Vines, et. al., 2000). The spatial impact of creosote treated wood, based on increases in sediment PAH, was localized (less than 10 meters [33 feet] for the small structures studied. No studies were found that evaluated the spatial extent of PAH attributed to large creosote wood structures (e.g., > 50 pilings).

Metals-Based Treated Wood

Long-term adverse environmental effects associated with CCA Type C and ACZA treated wood are manifested in the accumulation of contaminants in sediment and direct impacts to biota that may colonize a treated wood structure. Leaching rates of trace metals (primarily copper) from installations of CCA Type C and ACZA treated wood are greatest when the wood is first immersed in water. Comparatively, ACZA has initially higher rates of copper leaching when compared to CCA treated wood, however, leaching rates diminished more quickly in ACZA treated wood than in CCA treated wood. The differences between CCA Type C and ACZA treated wood are minor. More important, however, is that most environmental evaluations of metals based treated wood was conducted on CCA treated southern yellow pine. Additionally, most of that research was conducted in marine or estuarine environments.

The impact to the water column is a short-term event (days to weeks) and contaminants that are leached are ultimately deposited into sediments. Metals will not in the long term degrade; however, they may become mineralized, chemically sequestered, or physically sequestered. The role of acid volatile sulfides in bioavailability of metals is unresolved at this point, but likely is a major factor.

Impacts of leached metals to sediments were localized at and immediately adjacent to small treated wood structures. Increases in sediment metal concentrations were limited to within 10 ft or less of small treated wood structures in marine and freshwater habitats.

No adverse biological impacts from either sediment toxicity testing or *in situ* community changes were reported in the field studies reviewed. Adverse biological impacts were documented in Florida studies in areas of low water exchange where contaminants had accumulated in the sediments.

Impacts to Salmon

The most probable route of exposure to leached or diffused contaminants from treated wood for salmon is through the consumption of contaminated prey. Hence, exposure is greatest for salmon when they are feeding in areas of sediment deposition (low flow areas) immediately adjacent to treated wood structures. Once juvenile salmon enter larger rivers or engage in an open-water marine life stage, the potential to be adversely impacted by treated wood contaminants is very low. Areas where there are a large number of creosote treated structures pose the greatest risk to listed salmon. It is uncertain if that risk is significant (the actual intake of PAH from treated wood has not been quantified) and that the resulting exposure in those situations results in appreciable harm to migrating salmon. However, for ESA listed species the precautionary principle should be applied to reduce risk. For potential mitigation strategies for impacts to salmon, see the mitigation section below.

Data Gaps

Specific data gaps and research needs pertaining to this assessment of treated wood include the following:

- The influence of pH should be incorporated into the derivation of water quality standards for some metals, in particular, copper.

- Sediment quality standards for metals and organics need to be normalized to those variables that control their biological availability and potential toxicity (TOC, AVS, percentage fines, etc.).

- The relationship between hepatic lesions and reproductive biology of flat fish and sediment contaminants needs to be quantitatively evaluated to assess the combined and individual dose responses of PAH, chlorinated pesticides, PCBs, and trace metals. Early life stage exposure also needs to be evaluated when assessing impacts and developing sediment benchmarks.

- A better understanding is needed of elevated tissue burdens of contaminants in biota and any adverse effect that can be associated with that burden.

- Models for predicting effects of treated wood need to be evaluated in more detail.

- Avoidance behavior of aquatic organisms to chemical contaminants released from treated wood needs further evaluation.

- Metabolic transformation and photo-oxidation need to be better understood to evaluate the risk of PAH in aquatic habitats.

- Microbial and physical degradation processes for PAH need to be better understood to evaluate long-term risk of PAH in sediment.

- A better understanding is needed of diffusion rates of PAH from creosote treated pilings prepared under best management practices.

Potential Mitigation Strategies

While this white paper focuses primarily on impacts to salmonids, the preservation of wild salmonid populations is dependent on the preservation of suitable habitat and the biodiversity associated with healthy ecosystems. Therefore, suggested mitigation strategies include general strategies as well as those that are designed specifically to reduce impacts on salmon.

General Mitigation Strategies

For new installations, other materials could be used, such as metal, concrete, or other composite materials. Work may be scheduled to avoid exposure to contaminants. In addition, treated wood may be treated further to minimize release of chemical contaminants to the environment. Mitigation for the effects of existing structures could include placing sleeves over pilings to prevent spawning on pilings, installing additional spawning surfaces, and removing the installation. Where sediment is contaminated, pilings could be cut off below sediment grade and capped with clean sediment, leaving the butt intact but isolated from the surface sediments.

Salmon-Specific Mitigation Strategies

To reduce impacts on spawning salmon, creosote treated wood should not be installed in spawning areas of listed species of salmon. If metals based treated wood is to be used in areas where salmon spawn, then installations should be scheduled to allow for sufficient weathering to occur to avoid exposure to eggs and larvae and minimize exposure to juvenile salmonids. The amount of metals based treated wood that is immersed in water should be minimized where possible if it is used.

To reduce impacts on juvenile salmon, creosote treated wood structures should not be constructed in low flow areas (i.e., small tributaries) where juvenile salmon are migrating, or where they may feed for extended periods of time (nursery areas, estuaries). Metals based treated wood structures can be used in these situations, but again mitigation should be considered to minimize exposure to sensitive life stages of listed fish and consideration given to cumulative impacts.

Treated wood should be inspected before installation to ensure that there are not any superficial deposits of preservative material on the wood. To minimize releases of contaminants to the environment treated wood stored at construction sites before installation should be managed.

As policies for the installation and operation of treated wood structures in aquatic habitats are established, professionals working in the fields of aquatic toxicology, aquatic risk assessment, and resource management should be included in the process.